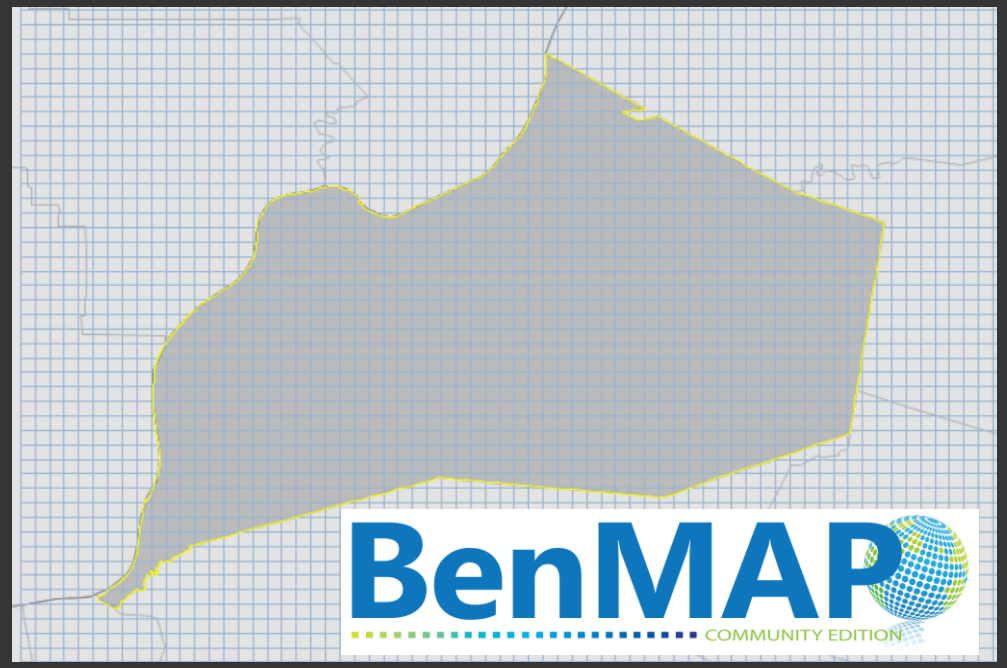
Concepts of Benefits Analysis & Using the BenMAP-CE Tool



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AIR POLLUTION CONTROL DISTRICT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Disclaimer

The views expressed are those of the authors and do not necessarily reflect the views or policies of the U.S. EPA.

Today's Discussion

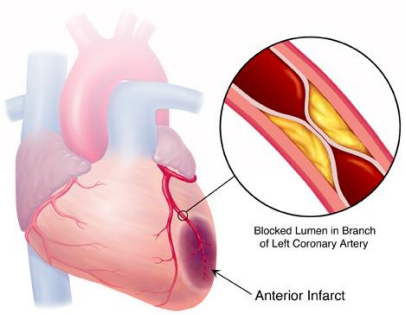
Objective: Share how the U.S. EPA conducts benefits analysis using BenMAP-CE and how it can be applied across communities

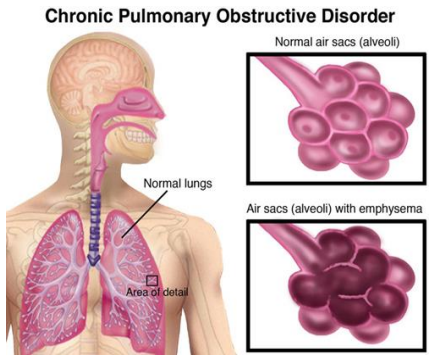
Health Benefits Background

Introduction to BenMAP-CE

Local-Scale Application

What are the Benefits of Improved Air Quality?





Reduces Health Risks

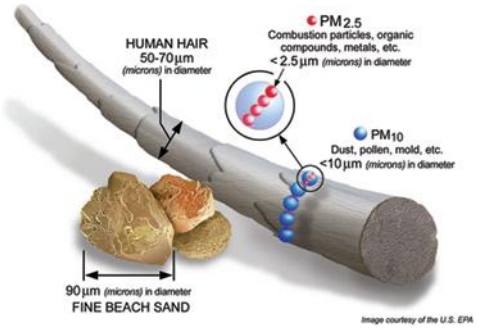
- Missed work
- School absences
- Hospital admissions
- Bronchitis
- Asthma attacks
- Heart attacks
- Chronic disease
- Premature death

Improves Environmental Quality

- Visibility
- Forest and crop yields
- Water quality
- Habitat
- Less acid deposition
- Less leaf damage

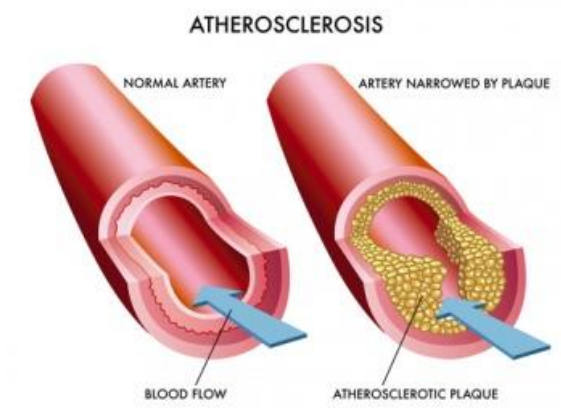
How Can Air Pollution Affect Health?

Industrial emissions



Fine particles

Clinical and Toxicological Research - Establishing the Biological Mechanisms



Human health impacts

Epidemiological Research
Quantifying the Magnitude of the Risk

Changes in Exposure
($PM_{2.5}$ and Ozone)

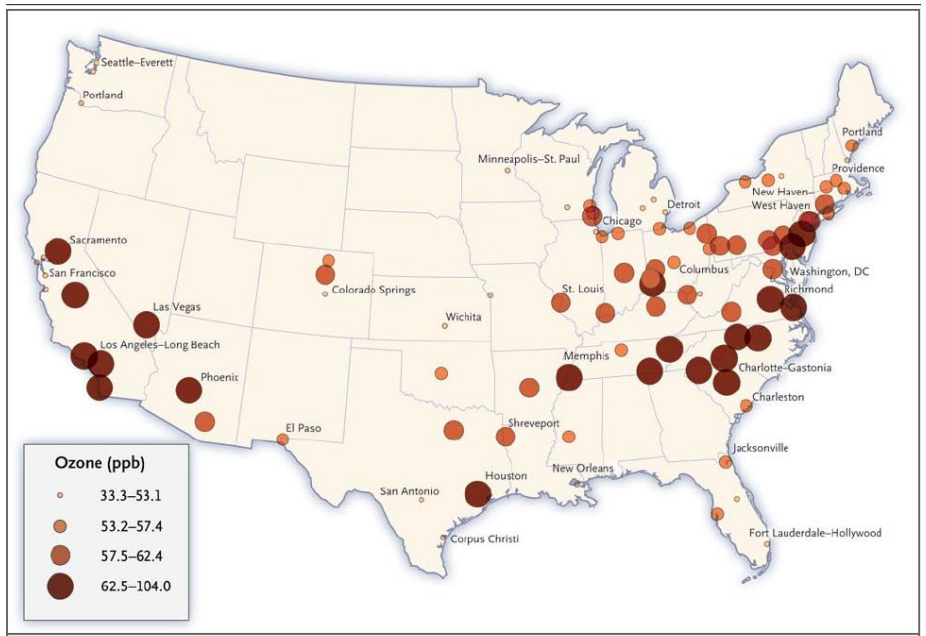


Figure 1. Ozone Concentrations in the 96 Metropolitan Statistical Areas in Which Members of the American Cancer Society Cohort Resided in 1982.

The average exposures were estimated from 1 to 57 monitoring sites within each metropolitan area from April 1 to September 30 for the years 1977 through 2000.

Concentration-Response Relationship
"Health Impact Function"

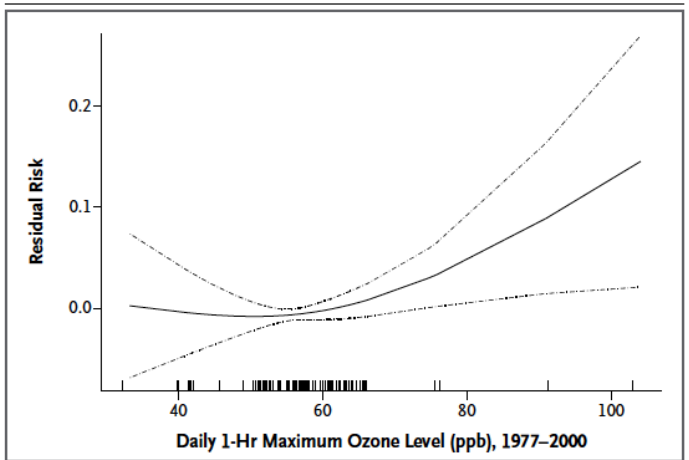


Figure 2. Exposure–Response Curve for the Relation between Exposure to Ozone and the Risk of Death from Respiratory Causes.

The curve is based on a natural spline with 2 df estimated from the residual relative risk of death within a metropolitan statistical area (MSA) according to a random-effects survival model. The dashed lines indicate the 95% confidence interval of fit, and the hash marks indicate the ozone levels of each of the 96 MSAs.

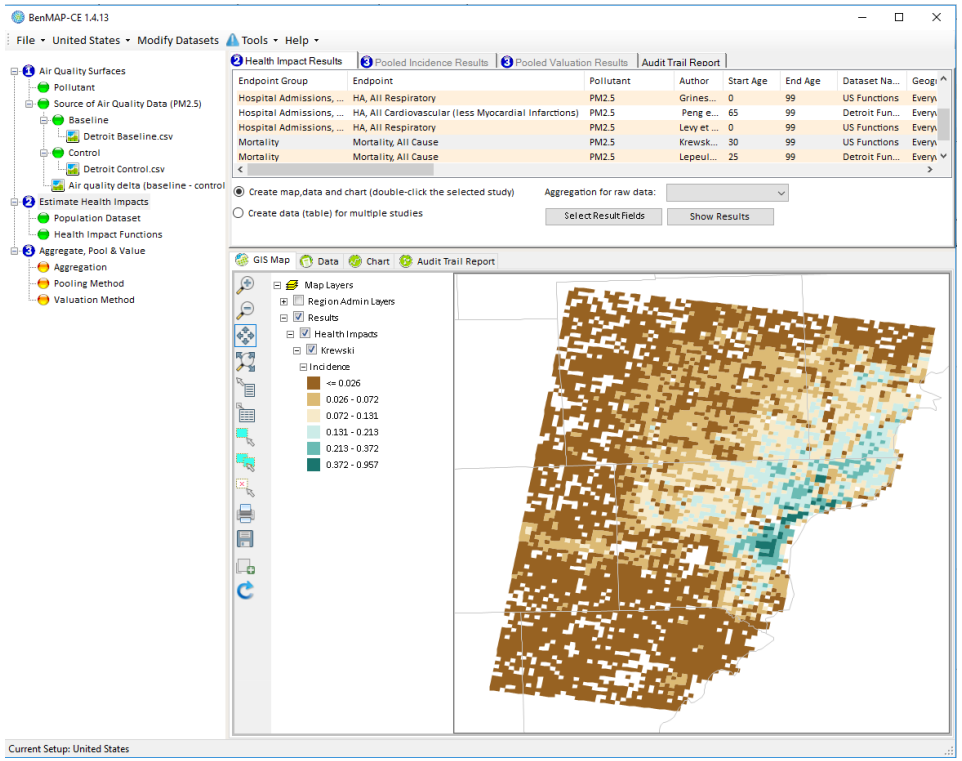
$$\Delta Y = Y_o \, (1 - e^{-\beta \, \Delta PM}) * Pop$$

How does EPA estimate the health impacts associated with improved air quality?

U.S. EPA's Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP – CE)

Free and open source program that allows users to use data supplied by EPA or their own data to estimate the health and economic benefits of various air quality scenarios

https://www.epa.gov/benmap



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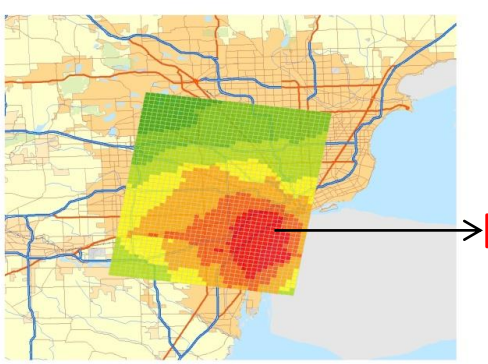
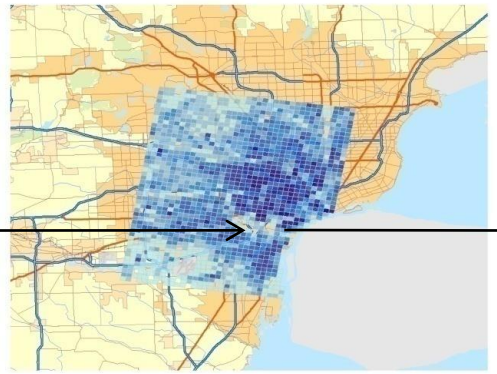
Steps to Calculating Health Impacts

Effect Estimate
(Concentration-Response Function)

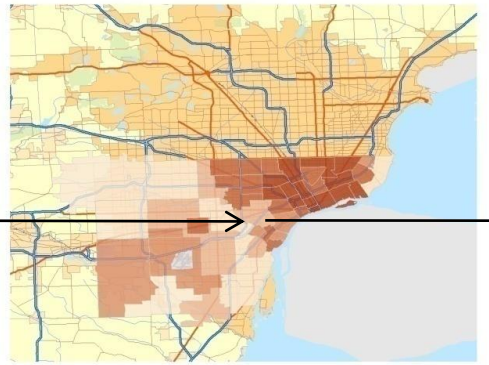
$$\Delta Y = Yo\,(1-e^{-\beta \Delta PM}) * Pop$$



Pollutant Reduction
(Improved Policy Scenario)



Affected Population
(Study: 30-99 Year Old)



Baseline Health Incidence
(Hospital Admissions/Death Rates)

Effect Estimate

Avoided **Health Outcomes**

School Loss Days
Acute Bronchitis
ER Visits
Hospital Admissions
Premature Death

BenMAP-CE

Air Quality Data

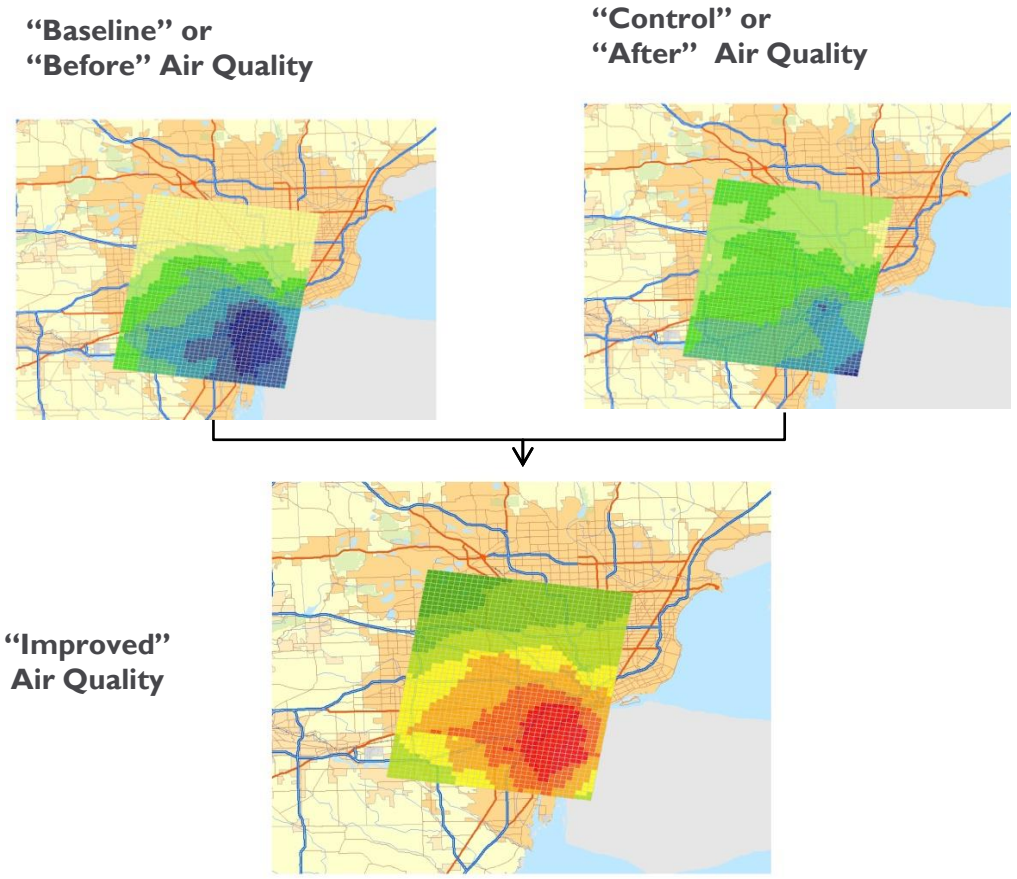
BenMAP-CE will accept:

- Photochemical grid model data
- User-provided or built-in monitoring data, which it interpolates to create a surface
- "Rolled-back" monitoring data that simulates a concentration change

BenMAP-CE requires:

- "Baseline" and "control" surfaces and calculates the incremental *difference* between those surfaces

$$\Delta Y = Y_o (1 - e^{-\beta \Delta PM}) * Pop$$



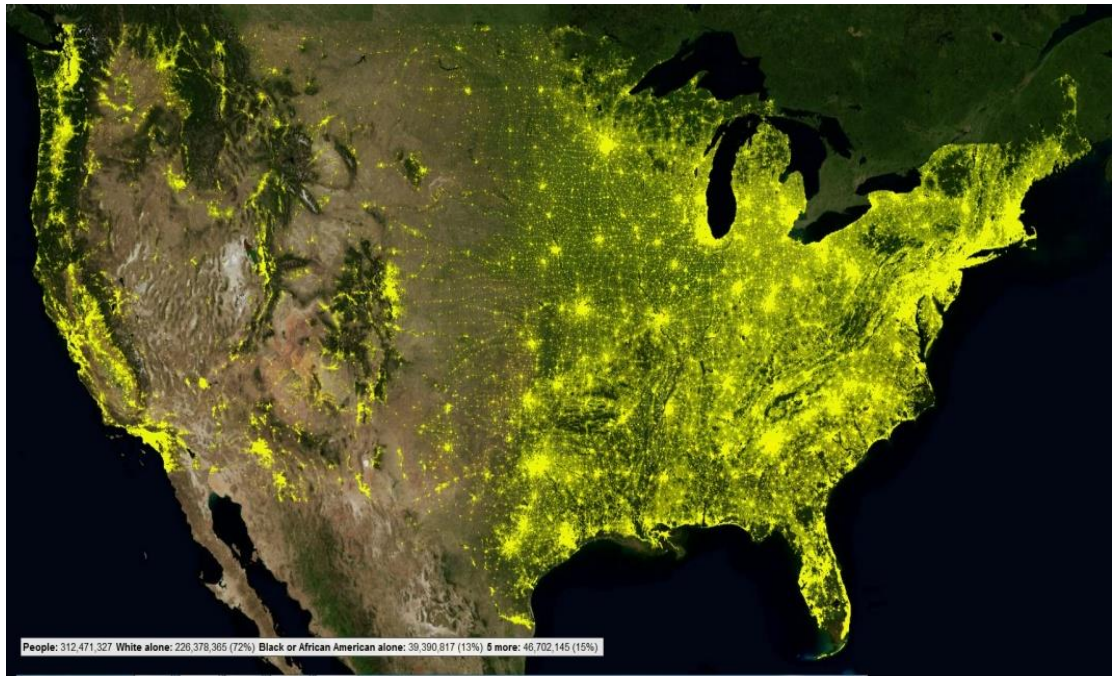
Population Data

$$\Delta Y = Y_o (1 - e^{-\beta \Delta PM}) * Pop$$

BenMAP-CE includes:

- U.S. population by age/sex/race/ethnicity
- Population projections for each year from 2000 to 2040
- 12 x 12 km grids or county-level resolution

User can also add their own population data



Baseline Incidence Rates

$$\Delta Y = Y_o (1 - e^{-\beta \Delta PM}) * Pop$$

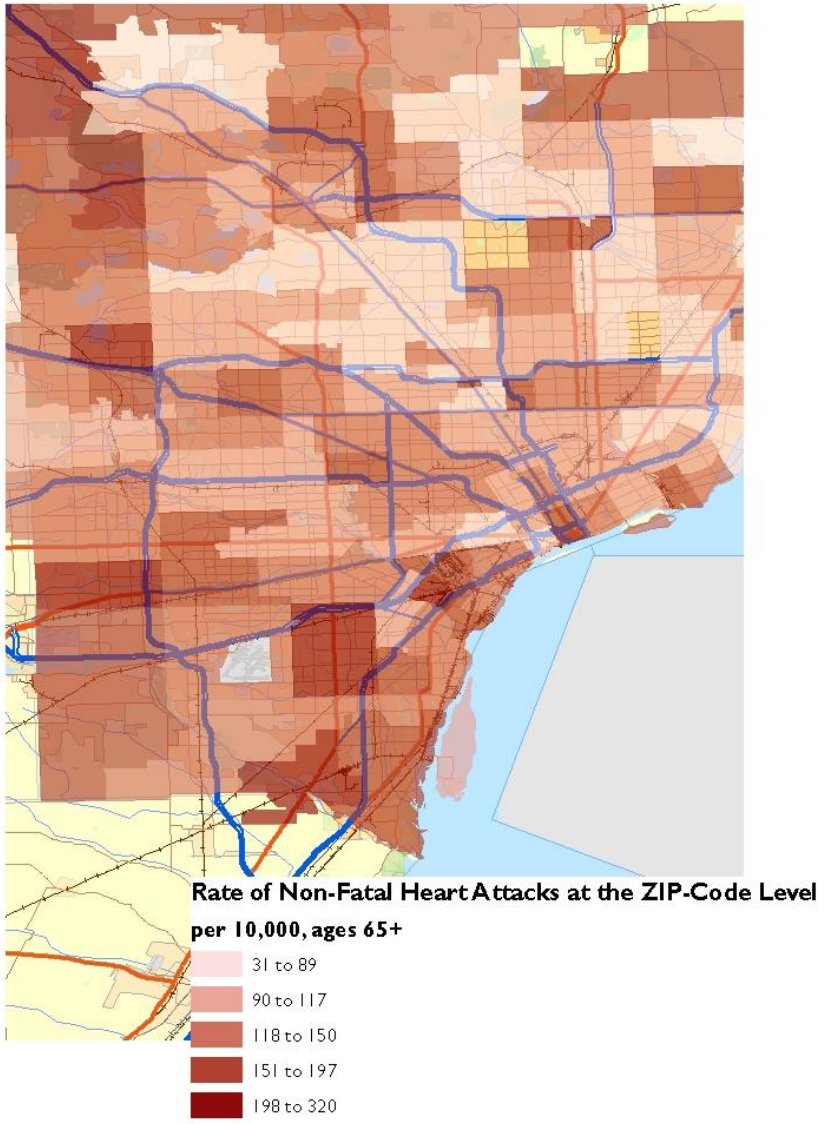
BenMAP-CE contains baseline incidence rates matched to each health impact function in the United States

- Mortality projections every 5-years from 2000 to 2050 in U.S.
- Morbidity only for 2000/2007/2014

For the U.S., the spatial resolution of pre-loaded rates vary by endpoint

- Premature mortality: by county
- Acute bronchitis: national-level
- Hospital and ER: some state and county rates available

Can add your own baseline incidence and prevalence rates



Health Impact Functions

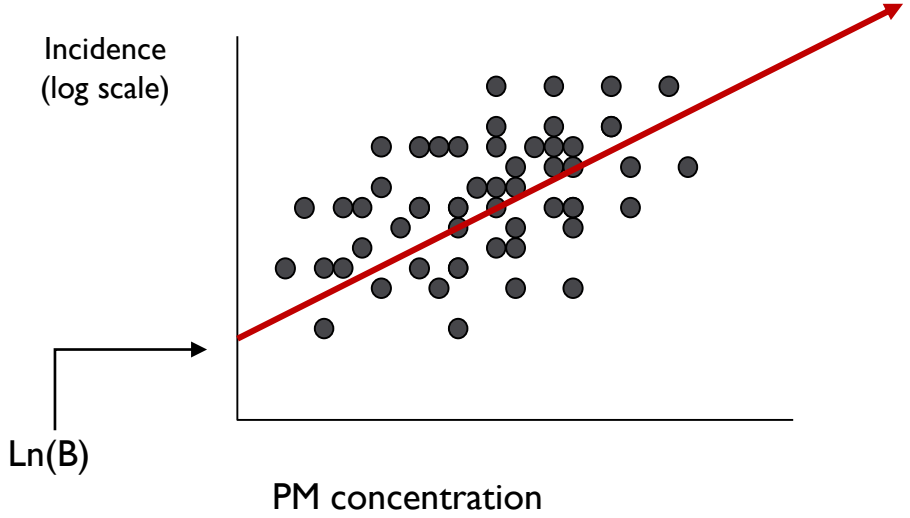
BenMAP-CE contains over 100 health impact functions for the U.S. and from overseas

Users can use EPA's default functions for Ozone and $PM_{2.5}$

- EPA's previous functions for NO_2, SO_2, and lead are also available

Users can add and edit their own health impact functions using the function editor

$$\Delta Y = Y_o (1 - e^{-\beta \Delta PM}) * Pop$$



Example:
"The authors estimate a 3% increase in deaths for every 10 μg/m³ increase in outdoor $PM_{2.5}$ from the previous day."

The End Result: Health Impact Estimates

"Avoided Adverse Outcomes"

Health Endpoint	Cases/Year
Lost Work Days (18-64) Ostro (1987)	1200 (1100-1400)
Asthma Exacerbation (6-18) Ostro et al. (2001), Mar et al. (2004)	271 (34-540)
Lower Respiratory Symptoms (7-14) Schwartz and Neas (2000)	180 (88-280)
Acute Bronchitis (8-12) Dockery et al. (2006)	14 (-.52-29)
Emergency Rooms Visits for Asthma (0-99) Glad et al. Mar et al. Slaughter et al. (2012)	5.5 (-.95-11)
All Cardiovascular Hospital Admissions (65-99) Zanobetti et al. (2009), Bell et al.2008, Peng et al. (2009)	1.9 (.88-3.7)
All Respiratory Hospital Admissions (65-99) Zanobetti et al. (2009), Kloog et al. (2012)	1.60 (-.70-3.2)
Premature Mortality (30-99) Krewski et al. (2009)	10 (7.5-13)

The South Carolina Project
A Local-Scale Analysis using BenMAP-CE

Project Goals:

Maximize both health benefits and air quality improvements.

Identify local control strategies to reduce both ozone and $PM_{2.5}$ precursor emissions while also reducing air toxics

Establish regional "air quality coalitions," engaging local communities in areas of the state that have issues with air quality.

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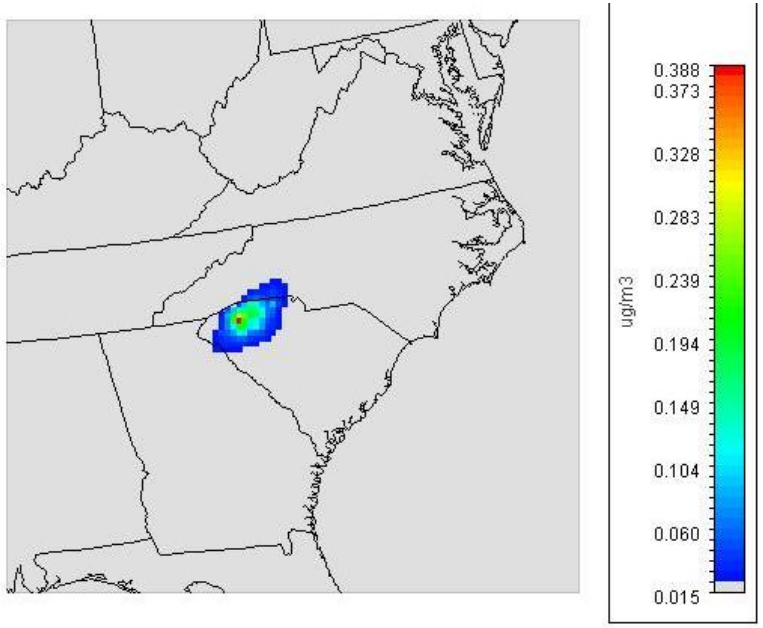
The South Carolina Project
A Local-Scale Analysis using BenMAP-CE

Project Details:

1. Control measures and their costs were identified.

2. Air quality modeling was conducted to assess emission reduction effects on ozone, $PM_{2.5}$, and other pollutants.

3. Risk exposure was assessed using the 2011 National Air Toxics Assessment (NATA) and BenMAP–CE.



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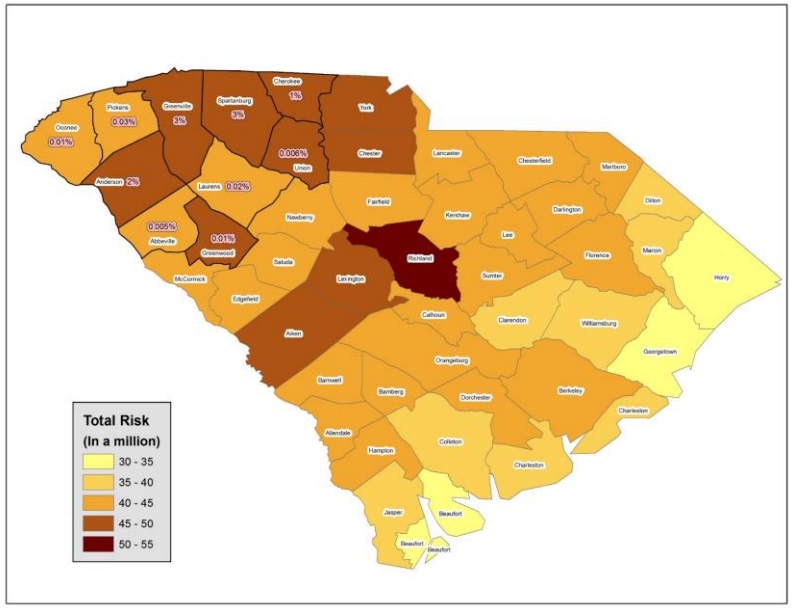
Lessons Learned

Improving air quality in areas already attaining the EPA Standards can still yield significant health benefits. (SC Project 5:1 benefit to cost ratio)

Reducing $PM_{2.5}$ and Ozone also has a co-benefit: reductions in air toxics

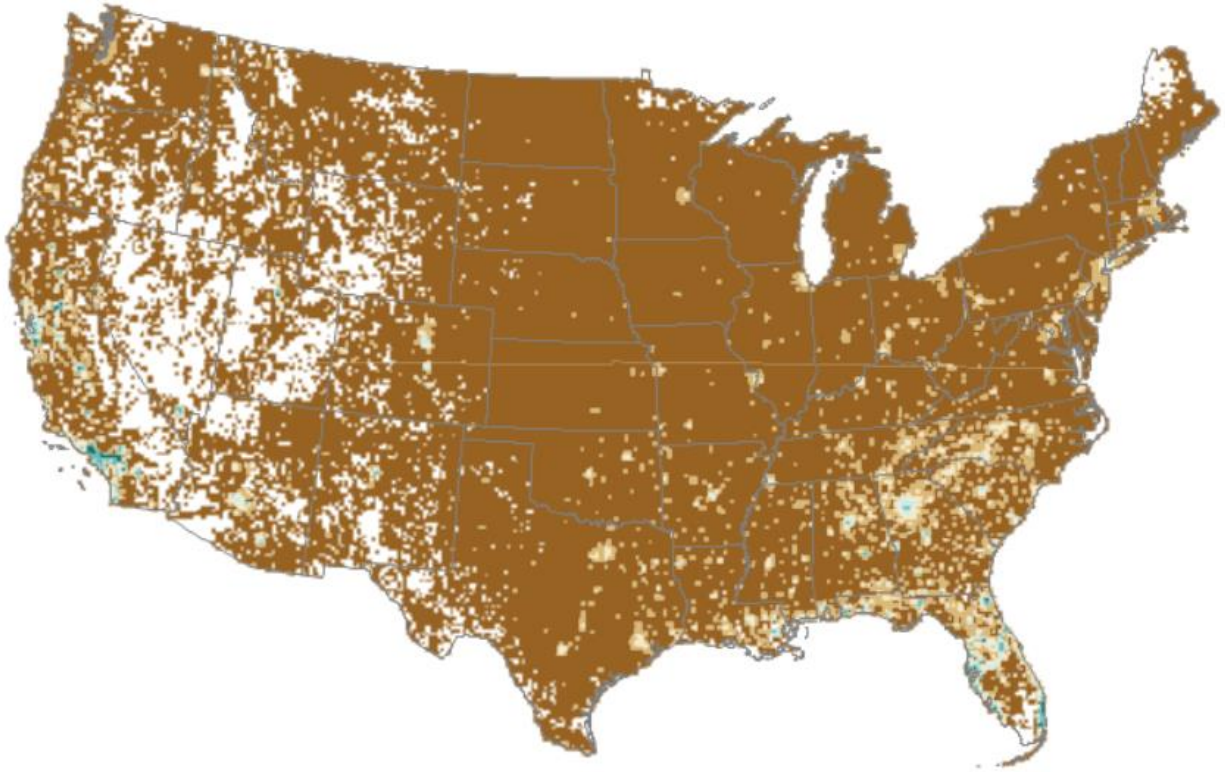
Local area perspective and expertise play a large role in successfully implementing any voluntary emissions reduction program.

Collaborations allow for better communication, knowledge transfer and feedback on effectiveness of programs.



Thank you!

www.epa.gov/benmap



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